SUPPLY AND REQUIREMENTS PROJECTIONS OF ENGINEERS CANADA 1976

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FOREWORD

This Study of one component of Canada's highly qualified manpower resources is one of a series of studies in the program of research in highly qualified manpower in the Department of Manpower and Immigration. It is the second in a series of projections of the supply and requirements of highly qualified manpower. It should be noted that the projections are based on a number of data and behavioural assumptions and that it is possible to derive alternative projections by changing some of these assumptions. Because of this, the projections will probably need to be revised from time to time as better data becomes available. The entire report should be read with this in mind especially if the results are to be used for planning purposes and practical decision making.

The study was carried out partially under contract by Dr. Neill Fortune and by Peter Ross of the Department of Manpower and Immigration. The advice of the Canadian Council of Professional Engineers was helpful in completing the study.

G. Saunders,
Director,
Research Branch.

G. Neil Perry
Assistant Deputy Minister,
Program Development Service.

INTRODUCTION

Looking ahead to 1976, if current trends continue, and of course there is no certainty that they will, there is a likelihood that the Canadian economy will have approximately the same number of engineers seeking employment as professional engineers as the market may be able to absorb. That is the message of this study. But much can happen between now and 1976 to affect both the demand and the supply outlook; the message, therefore, can only have a short span of validity.

Our purpose in publishing the results of this study is to alert all the interested parties to the consequences of the present tendencies and to learn with experience how to improve both the methodology and, naturally, the utility of studies in this field.

It is hoped that a periodic updating of the projections can be implemented so that the effect of annual events such as enrolments on the projected market situation can be quickly ascertained.

CHAPTER 1

THE STOCK OF CANADIAN ENGINEERS

1.1 Data on the Stock of Engineers

The 1961 Census and the 1967 Survey of Highly Qualified Manpower of the Department of Manpower and Immigration are the only recent sources of data on the stock of Canadian engineers. The purpose of this study is to examine and project the supply and requirements for engineers to 1976. A certain amount of disaggregation will be involved.

1.2 The Census, 1961

According to the Census, Canada had 43,066 engineers in 1961. The definition of engineers used in the Census is extremely broad. As a result, in some cases, it would include individuals with only a limited amount of professional experience such as draftsmen, certain types of mechanics and so on.

The distribution of engineers according to the field of employment, specialization or occupation in the 1961 Census was:

TABLE 1.1

DISTRIBUTION OF ENGINEERS, CENSUS, 1961

Field of Employment, Specialization or Occupation	Number	Per Cent
Engineering, Total	43,066	100
Chemical	2,996	7
Civil	11,917	28
Electrical	8,763	20
Mechanical	12,099	28
Other	7,291	17

Source: Dominion Bureau of Statistics, Labour Force Bulletin 31-9, 1961, Table 17.

1.3 The 1967 Survey

In 1967, the Department of Manpower and Immigration conducted a Survey of Professional, Scientific and Technical Manpower. Engineers were among the respondents. Engineers were defined as those who had a degree in engineering or those with a degree or professional certification whose work activity in 1966 was classified as engineering or related to engineering. By field of study 37,842 engineers were identified which is as will be seen an underestimate of the number of persons with engineering qualifications.

To project requirements for engineers, it is necessary to identify those people who are actively involved in an engineering type activity irrespective of work function (management, R & D etc.) and previous post-secondary education. According to the respondents to 1967 Survey, only 30,321 of 37,842 engineers by field of education were actively involved in engineering. At the same time 33,412 respondents identified their jobs as engineering type jobs. Therefore, 3,091 (33,412 - 30,321) persons without formal engineering degrees regarded themselves as doing engineering work. Because of the similarity between engineering and the natural and life sciences, it was decided to only deduct from the 37,842 engineers by education, the 1,528 who considered themselves as social scientists and the 3,573 who could not be categorized. Those who could not be categorized are probably legitimately counted as not being in engineering as anyone who is an engineer probably took the minimal effort to so indicate. Therefore, in conclusion, it was decided to regard 35,832 (37,842 + 3,091 - 1,528 - 3,573) of the persons covered in the 1967 Survey as holding engineering jobs. Therefore, positions for engineers (35,832) are 94% (35,832/37,842) of the number of engineers by field of study (37,842). This percentage will be utilized to arrive at the total number of persons involved in engineering in 1966.

According to the records of the Canadian Council of Professional Engineers (C.C.P.E.), there were 51,377 persons registered as of December 31, 1966. The C.C.P.E. estimates that of the above total which they consider to represent 85% of the actual total, approximately 1,000 were duplicate (provincial) registrations and approximately 1,500 were not working in Canada. Deducting the 1,000 duplications and 1,500 not working in Canada yields a total of 57,502 if the 85% coverage factor is applied. If it is assumed as previously deduced that 94% of total engineers yields the number of people involved in engineering then the final total consists of 54,051 engineering positions in 1966. This estimate of 54,051 will be used throughout the study.

The 1967 Survey subdivides engineers by field of specialization. Adjusting each category for the stock decided upon (54,051) yields the following results.

TABLE 1.2

CLASSIFICATION OF CANADIAN ENGINEERS BY FIELD OF SPECIALIZATION

Field of Principle Employment	Number	Per Cent
1. Aeronautical	583	1.1
2. Ceramic	200	.4
3. Chemical	2,428	4.5
4. Civil	8,902	16.5
5. Electrical Total	9,885	19.5
6. Geological	405	.7
7. Industrial	7,506	13.9
8. Marine	335	.6
9. Materials	1,004	1.9
10. Mechanical	4,517	8.4
11. Metallurgical	1,319	2.4
12. Mining	1,996	3.7
13. Nuclear	262	.5
14. Petroleum	2,538	4.7
15. Surveying	446	.8
16. Textile	239	.4
17. Transportation	874	1.6
18. Engineering n.e.s.	9,930	18.4
Totals	54,051	100.0

Source: A. G. Atkinson, K. J. Barnes and Ellen Richardson, Canada's Highly Qualified Manpower Resources, Research Branch Program Development Service, Department of Manpower and Immigration, Canada, 1970, pp. 258 and 259

Thus, the stock of engineers for 1961 and 1966 that will be used throughout the rest of this study are: 1961 - 43,066 engineers and 1966 - 54,051 engineers. The simple growth rate through the reference years is 5.1%.

CHAPTER 2

PROJECTIONS OF 1976 REQUIREMENTS FOR ENGINEERS

2.1 Methodology

The procedure used here largely involves projections of the demand for engineers by the use of rates of change of certain variables and regressions on other relevant variables. Disaggregation into four categories is used. The employment distribution as found in the 1967 Survey is revised upward due to the underestimate and the D.B.S. data on university teachers are utilized.

TABLE 2.1

EMPLOYMENT DISTRIBUTION OF ENGINEERS, 1967 SURVEY

Employer	Number	Per Cent
Industry		
Manufacturing	21,214	39.2
Non-manufacturing	23,213	42.9
Total Industry	44,427	82.1
Education (University)	976	1.8
Government	8,648	16.1
Total	54,051	100.00

2.2 Projected Demand for all Engineers in Canadian Industry

This section projects 1976 requirements for engineers in Canadian industry where the term "industry" includes all employment except employment in government or education. Since 81 per cent of engineers are engaged in industry, it was decided to subdivide engineers in industry into manufacturing and non-manufacturing. Since productivity growth rates in manufacturing are much higher than in non-manufacturing,

this subdivision is essential. No further disaggregation is possible as will be seen in the following analysis. Thus, it is necessary to assume that final demands within the different manufacturing and non-manufacturing sectors in the most recent year is in the same proportion as it was in the base year (1966).

In 1969, the Economic Council of Canada estimated the average growth rate from actual output in 1967 to potential output in 1975 at about 5.5 per cent per year. This growth rate is composed of a 3.7 per cent growth in factor input (labour 2.5 per cent and capital 1.2 per cent) and a growth in factor productivity of 1.8 per cent.1/

The Dominion Bureau of Statistics has constructed productivity indicies for various years in certain sectors of industry. These are presented in Table 2.2:

TABLE 2.2

AVERAGE ANNUAL RATE OF PRODUCTIVITY GROWTH

Time Period	Commercial Industries	Non-agricultural Commercial Industries	Manufacturing Industries	Non-manufacturing Industries
1946-47	3.50	2.80	2.70	2.30
1961-64	2.95	2.20	3.80	1.50
1963-67	2.30	1.90	2.80	1.40

Source: Dominion Bureau of Statistics, Aggregate Productivity Trends, 1946-67, Cat. No. 14-201.

1/ Economic Council of Canada, Sixth Annual Review, 1969.

The procedure to obtain the demand for engineers in manufacturing and non-manufacturing in 1976 involved the use of these productivity figures together with the estimates of the number of engineers in these sectors. First, assume that productivity in each sector will continue to grow at the same rate between 1967-76 as it did between 1963-67. Then assume that real output in each sector will grow at the same rate as total output. Finally, assume that employment of engineers in each sector is a constant proportion of total employment in that sector. Lack of any other information makes these assumptions necessary. However, they can easily be revised in the light of future evidence with respect to recent productivity growth.

The productivity growth rate in manufacturing was 2.80 per cent. Since real output grew at 5.5 per cent between 1961-68, and is expected to continue to grow at this rate from 1967-75, employment would then be expected to grow at 2.7 per cent per year. If engineering employment is to remain a constant proportion of total employment in manufacturing, it will also have to increase at the rate of 2.7 per cent per year. The application of this growth rate to the 21,214 engineers engaged in manufacturing yields the following estimates of the demand for engineers:

TABLE 2.3

PROJECTED REQUIREMENTS FOR ENGINEERS IN MANUFACTURING IN 1976

Year	Number
1966	21,214
1976	27,578

The productivity growth rate in non-manufacturing was 1.4 per cent. Since real output is expected to grow at 5.5 per cent, this means that employment of engineers in non-manufacturing must grow at 4.1 per cent per year. The application of this growth rate to the 23,213 engineers engaged in non-manufacturing yields the following estimates:

TABLE 2.4

PROJECTED REQUIREMENTS FOR ENGINEERS
NON-MANUFACTURING IN 1976

Year	Number
1966	23,213
1976	34,611

This means that there will be a total demand for engineers in industry of 27,578 + 34,611 or 62,189 in 1976.

2.2(a) Projected Requirements for Engineers in Canadian Universities

Requirements for engineers in Canadian universities are largely, but not entirely dependent upon future student enrolments and trends in the student-faculty ratio.

2.2(b) University Enrolment

Zsigmond and Wenaas in Enrolment in Educational Institutions by Province, 1951-52 to 1980-81 (Staff Study No. 25 for the Economic Council of Canada) project 1975-76 enrolment in universities including teachers colleges at 560,000 students. In order to remove teachers' college enrolments, the ratio of teachers' college enrolments for 1956-57 to 1967-68 was projected to 1980. The resultant estimate was subtracted from the total enrolment projections of Zsigmond and Wenaas. This means that there were 515,310 students enroled in universities, excluding teachers colleges.

2.3(a) The Student-Faculty Ratio

Table 2.5 gives estimates of the number of university teachers from 1957-58 to 1966-67. The number of university teachers increased at an average annual rate of 11.84 per cent over the ten-year period. However, the relatively more rapid growth in enrolments has prevented

any long-run improvements in the number of faculty members per student. The total number of university students increased from 86,754 in 1957-58 to 232,672 in 1966-67. Thus, the student-faculty ratio has increased from 11.57 in 1957-58 to 14.21 in 1966-67. The best relationship between the student-faculty ratio, S/F and time T is given by the linear relation.

$$S/F = 9.69 + 0.23\ T$$

where T = 1 in 1953 and T = 24 in 1976. On this basis, the projected student faculty ratio is 15.21 students per staff member in 1976. Since enrolment in 1976 is projected to be 515,310 students, the projected requirements for university teachers is 33,879 in 1976.

2.3(b) Projections of the Demand for University Engineering Teachers

Table 2.5 indicates that the ratio of engineering teachers to total university teachers has remained virtually unchanged over the period 1957-58 to 1965-66.

TABLE 2.5

ENGINEERING TEACHERS IN CANADIAN COLLEGES AND UNIVERSITIES

Year	University Engineering (1)	Teachers Total (2)	Ratio
1957-58	462	7,500	.0616
1958-59	519	8,200	.0633
1960-61	672	9,755	.0689
1962-63	786	11,670	.0674
1963-64	847	12,940	.0655
1965-66	976	16,000	.0610

Sources: (1) DBS, Cat. No. 81-203, Table 11

(2) DBS, Cat. No. 81-211, Part 11, various issues.

If a linear trend is estimated, the resultant equation is

$$F_E/F = .0635 + .000038\ T$$

where F_E represents engineering teachers and T = 1 in 1957-58. The projected ratio in 1976 (T = 19) is .0642. The demand for university engineering teachers in 1976 will be .0642 x 33,879 = 2,175.

TABLE 2.6

PROJECTED REQUIREMENTS FOR ENGINEERS IN UNIVERSITY

Year	Number
1966	976
1976	2,175

2.4 Projected Demand for Engineers in the Canadian Government

Government employment of engineers is assumed to be a function of government expenditure on goods and services. Since government employment of engineers is only available for 1966, the year of the D.M.I. Survey, the procedure used was to project government expenditure through time to 1976, and then assume that the ratio of government employment of engineers to government expenditure on goods and services will be the same in 1976 as it was in 1966.

TABLE 2.6

GOVERNMENT CURRENT EXPENDITURE ON GOODS AND SERVICES

Year	Millions of Dollars
1955	4,036
1956	4,426
1957	4,573
1958	4,854
1959	4,976

1960	5,281
1961	6,350
1962	6,770
1963	7,149
1964	7,684
1965	8,307
1966	9,820
1967	10,875
1968	12,078

Source: DBS, National Accounts, Income and Expenditure Cat. No. 13-201.

The equation used to project government expenditures is:

$$G = 2549.4 + 585.6\ T$$

where T = 1 in 1955, and T = 22 in 1976. The projected value of government expenditures is 15432.4 million dollars in 1976. The government employed 8,648 engineers in 1966 according to the revised D.M.I. Survey. Government expenditures on goods and services was 9,820 million dollars in 1966 giving a ratio of 0.8806 engineers per million dollars of government expenditure. If this ratio remains constant until 1976, the government will employ 13,590 engineers in 1976.

2.5 Summary of the Requirements for Engineers

The projected requirements for engineers in 1976 in each of the four classifications is presented below.

TABLE 2.7

PROJECTED REQUIREMENTS FOR ENGINEERS IN 1976

Industry	
Manufacturing	27,578
Non-manufacturing	34,611

Total Industry	62,189
Government	13,590
Education	2,175
Total	77,954

2.5(a) Qualifications

The precision of the estimates obtained in this study is entirely dependent upon the accuracy of the data, the assumptions mentioned above, and any shifts in the regression coefficients over time. If the growth rates of gross national product, government expenditures, productivity, student-faculty ratios etc., change, the resultant demand for engineers will, of course, be affected, although the effects of changes in some of these variables may be offsetting.

CHAPTER 3

PROJECTIONS OF THE 1976 SUPPLY OF ENGINEERS

3.1 Methodology

The projected supply of any profession in a given year is composed of the stock in the previous year plus entrants into the profession either from universities or immigration plus exits due to retirements, deaths, emigration and occupational ability.

The following equation is used to account for the flows of professional engineers in order to obtain supply projections:

$$S = S_b + b + m + d + i - e - r - o$$

where

S = projected supply (stock)

S_b = stock in the last year before the projection period.

b = projected number of bachelor's degrees in the discipline which entered the labour market, i.e., did not go on to graduate work.

m = projected number of master's degrees in the discipline which entered the labour market, i.e., did not go on to further graduate work.

d = projected doctoral degrees

i = projected immigrants in the discipline.

e = projected emigrants in the discipline.

r = retirements and deaths over the projection period.

o = those who left the discipline for other fields of employment minus those who entered from other fields of employment.

3.2 Supply Projections

3.2(a) Base Year Stock

In Chapter 1, it was estimated that there were 54,051 engineers in 1966. The 54,051 will be used as the base year stock for the projections to 1976. The 1961 stock estimate of 43,066 will also be utilized when considering occupational mobility.

3.2(b) Bachelor's Degrees

Undergraduate engineering enrolment statistics for the years 1956-57 to 1969-70 were taken from D.B.S. data. Undergraduate engineering enrolments were regressed on total enrolment for the period 1956-57 to 1969-70 in order to project undergraduate engineering enrolments to 1976.

The projections are found in Table 3.1 below. It should be noted that the total enrolment statistics as explained in Chapter 1 are exclusive of teacher's college enrolments.

TABLE 3.1

TOTAL AND ENGINEERING UNDERGRADUATE ENROLMENT

Year	Total Enrolment Excluding Teacher's Colleges E(1)	Undergraduate Enrolment Engineering E_E E(2)
1956-57	78,504	13,056
1957-58	86,754	14,529
1958-59	94,994	14,826
1959-60	101,934	14,710
1960-61	113,864	14,632
1961-62	128,894	14,631
1962-63	141,388	14,369
1963-64	158,388	14,895
1964-65	178,238	15,276
1965-66	205,888	16,513
1966-67	232,672	18,498
1967-68	261,207	20,840
1968-69	266,719	22,173

1969-70	294,536	21,886
1970-71	324,022	22,593
1971-72	357,334	23,892
1972-73	396,804	25,430
1973-74	431,796	26,795
1974-75	474,719	28,468
1975-76	515,310	30,050
1976-77	554,407	31,574
1977-78	594,251	33,128
1978-79	628,123	34,448
1979-80	663,814	35,840

Sources: (1) Zsigmond, Z.E., and C.J. Wenaas, Enrolment in Educational Institutions by Province, 1951-52 to 1980-81.

(2) Dominion Bureau of Statistics. Cat. No. 81-204, 1954-55 to 1969-70.

The Dominion Bureau of Statistics published figures on the number of bachelors degrees granted in Canadian universities over the period 1956-57 to 1967-68 are used to obtain bachelors degrees in engineering to 1975-76. These degrees were regressed on the engineering enrolment obtained previously.

The data on bachelor degrees from 1956-57 to 1967-68 together with the corresponding projections are presented in Table 3.2.

TABLE 3.2

BACHELORS DEGREES IN ENGINEERING

Year	Number
1956-57	1,741
1957-58	1,930
1958-59	2,057
1959-60	2,171
1960-61	2,412
1961-62	2,437

1962-63	2,246
1963-64	2,422
1964-65	2,256
1965-66	2,241
1966-67	2,420
1967-68	2,688
1968-69	2,936
1969-70	3,243
1970-71	3,301
1971-72	3,418
1972-73	3,543
1973-74	3,733
1974-75	3,959
1975-76	4,196
1976-77	4,432
1977-78	4,676
1978-79	4,907
1979-80	5,130

Source: DBS, Cat. No. 81-211, Table 24.

3.2(c) Masters Degrees

A similar procedure was used to obtain the number of masters degrees. However, certain additional difficulties with regard to the availability of data were encountered. The Dominion Bureau of Statistics did not begin to collect data on graduate enrolment in engineering until 1961-62. Data on graduate enrolment are then available from 1961-62 to 1969-70. However, the National Research Council presented figures for the period 1954-55 to 1956-57. These were used together with the DBS figure to obtain estimates of the graduate enrolment in engineering over the intervening period 1957-58 to 1960-61 by means of a process of interpolation. The lack of any subdivision of graduate enrolment into Masters enrolment and Doctoral enrolment in engineering until 1969-70 was an additional difficulty. In order to obtain a breakdown of masters and doctoral enrolment, it was assumed that the ratio of masters to doctoral enrolment was the same in all previous years as in 1969-70. The only exception was the period 1954-55 to 1956-57 when the N.R.C. data on Masters and Doctoral enrolments were available. This breakdown of graduate students is at best suspect and therefore, only the aggregate

number of graduate students (master's plus doctor's) should be treated as very reliable, on the basis of the previous assumption.

The following table represents historical graduate enrolments (1956-57 to 1969-70) in engineering, together with projections to 1979-80. The ratio referred to earlier was used to separate masters from doctoral enrolments to 1979-80.

These figures are adjusted later to account for those going on to graduate school in order to obtain the number of bachelors degrees entering the labour market. It is known that some graduate engineering students spent some time in full time employment before entering graduate school. Therefore, the method utilized will somewhat distort the annual number of bachelors degrees entering the labour market but will not affect the over-all labour market balance.

TABLE 3.3

GRADUATE ENROLMENT IN ENGINEERING

Year	Total	Masters	Doctorate
1956-57	356	272	84
1957-58	417	307	110
1958-59	478	341	137
1959-60	538	376	162
1960-61	599	410	189
1961-62	660	445	215
1962-63	867	584	283
1963-64	1,129	760	369
1964-65	1,376	927	449
1965-66	1,723	1,161	562
1966-67	2,031	1,368	663
1967-68	2,585	1,741	844
1968-69	3,023	2,035	988
1969-70	3,183	2,144	1,039
1970-71	3,281	2,205	1,076
1971-72	3,692	2,479	1,213
1972-73	4,177	2,803	1,374
1973-74	4,607	3,090	1,517
1974-75	5,136	3,443	1,693
1975-76	5,628	3,776	1,852
1976-77	6,116	4,097	2,019

1977-78	6,606	4,424	2,182
1978-79	7,024	4,703	2,321
1979-80	7,463	4,996	2,467

Source: See Table 3.1

The Dominion Bureau of Statistics has collected data on masters and doctoral degrees from 1956-57 to 1969-70 in engineering. The masters degrees projection was obtained by regressing masters degrees from 1956-57 to 1969-70 on the average of the current year plus two previous years enrolment for the corresponding period. The historical data for the years 1956-57 to 1969-70 are presented in Table 3.4 below along with the projections.

TABLE 3.4

Year	Masters Degrees In Engineering
1956-57	97
1957-58	119
1958-59	149
1959-60	166
1960-61	202
1961-62	242
1962-63	286
1963-64	341
1964-65	435
1965-66	483
1966-67	498
1967-68	665
1968-69	761
1969-70	867
1970-71	897
1971-72	962
1972-73	1,078
1973-74	1,196
1974-75	1,321
1975-76	1,454

1976-77	1,581
1977-78	1,706
1978-79	1,824
1979-80	1,935

3.2(d) Doctoral Degrees

An analogous procedure was used to obtain doctoral degrees. Doctoral degrees were regressed on doctoral enrolment to obtain degree projections to 1979-80.

The resultant estimates are presented in Table 3.5.

TABLE 3.5

Year	Doctoral Degrees in Engineering
1956-57	12
1957-58	17
1958-59	19
1959-60	14
1960-61	19
1961-62	20
1962-63	26
1963-64	42
1964-65	49
1965-66	101
1966-67	95
1967-68	106
1968-69	129
1969-70	149
1970-71	157
1971-72	170
1972-73	193
1973-74	216
1974-75	240
1975-76	266
1976-77	291
1977-78	316
1978-79	339
1979-80	360

3.2(e) Total Labour Market Supply from Educational Institutions

(1) Bachelors Degrees Entering the Labour Market

A certain proportion of total bachelors degrees will continue their studies in graduate school rather than enter the labour market. To obtain the number of bachelor's degrees entering the labour market, it is necessary to subtract from total bachelor's degrees, those going into masters programs, and those going directly into doctoral work. It is assumed that all masters and doctoral students in engineering received a bachelors degree in that field.

As a first approximation, bachelors degrees entering the labour market in year t will equal total bachelors degrees in year t minus masters degrees in year t + 1 minus the percentage of bachelor degrees going directly into doctoral work times the number of Ph.D. degrees in year t+4 (i.e. it is assumed that it takes one year to obtain a masters degree and four years to obtain a Ph.D. degree after obtaining a bachelors degree in year t). This implies that the number of students entering graduate school and failing to obtain a degree is a constant from year to year.

Now, according to the National Research Council, only 50 per cent of the students obtaining masters degrees are Canadian. The remainder are either immigrants or foreign students who did not obtain their bachelors in Canada. The corresponding figure for Ph.D. students is 77 per cent Canadian.

Thus, it is necessary to revise the above equation to account for this. Thus, bachelors degrees in the labour market (B_L) in time t will now equal total bachelors degrees (B) in time t minus the percentage of Canadians with masters (% C_M) times the number of masters degrees (M) in time t + 1 minus the percentage of Ph.D. degrees with only a Bachelor's degree previously (P_B) in time t + 4 times the percentage of these that are Canadian (% C_p)

$$B_{Lt} = B_t - \%\, C_M . M_{t+1} - \%\, P_B . P_{t+4} . \%\, C_p$$

According to the National Research Council, 33 per cent of students enroled in Ph.D degree courses in science and engineering have only a bachelors degree. Substitution of the appropriate percentages in the above equation gives:

$$B_{Lt} = B_t - .50\, M_{t+1} - .33\, P_{t+4} .77$$

(ii) Masters Degrees Entering the Labour Market

According to the National Research Council, 67 per cent of the graduate students enroled for a doctorate in engineering at Canadian Universities for the year 1967-68 had a masters degree. It is assumed that all immigrant doctoral students received their masters degrees in Canada. In accordance with the time periods in section (1), it is assumed that a graduate student receiving his masters degree in time t will, if he is successful, receive his doctoral degree in time t + 3 and will be placed on the labour market at that time.

Thus, masters degrees entering the labour market in time t (M_L) will equal total masters degrees in time t (M) minus .67 of doctoral degrees in time t + 3 (D).

$$M_{L_t} = M_t - D_{t+3} .67$$

(iii) Doctorates Entering the Labour Market

It is assumed that all persons receiving doctorates enter the labour market. Postdoctoral students are assumed to be on the labour market, hired as researchers.

(iv) Total Degrees Entering the Labour Market

The results of the calculations outlined previously are presented in Table 3.6.

TABLE 3.6

DEGREES IN ENGINEERING ENTERING THE LABOUR MARKET

Year	Bachelors Degrees	Masters Degrees	Doctoral Degrees	Total
1961-62	2,268	209	20	2,497
1962-63	2,051	218	26	2.295
1963-64	2,177	277	42	2,496
1964-65	1,981	364	49	2,394
1965-66	1,954	397	101	2,452
1966-67	2,047	398	95	2,540
1967-68	2,265	560	106	2,931
1968-69	2,453	647	129	3,229
1969-70	2,740	738	149	3,627

1970-71	2,759	752	157	3,668
1971-72	2,811	801	170	3,782
1972-73	2,871	900	193	3,964
1973-74	2,993	1001	216	4,210
1974-75	3,146	1109	240	4,495
1975-76	3,314	1227	266	4,807

3.3 Net Migration

Thus far, no account has been taken of the number of deaths, retirements, migrations and persons entering from or leaving for fields other than engineering. Net migration is considered in this section.

Immigration and emigration data is used for the years 1960 to 1967. This data, together with the net migration figures are presented in Table 3.7.

TABLE 3.7

IMMIGRATION, EMIGRATION AND NET MIGRATION OF ENGINEERS

Year	Immigration (1)	Emigration (2)	Net Migration (3) = (1) - (2)
1960	725	881	-156
1961	547	811	-264
1962	967	880	87
1963	1,198	834	364
1964	1,476	821	655
1965	2,254	913	1,341
1966	3,210	998	2,212
1967	3,704	1,315	2,389

Sources: Immigration Statistics. Statistics Section. Department of Citizenship and Immigration, Canada, 1960 to 1962.

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Note: Emigration figures pertain only to those engineers migrating to the United States.

Net migration of engineers into Canada increased by 2,746 per cent during the period 1962-67. It would be extremely unlikely that this growth rate of net migration of engineers into Canada will continue until 1976. Thus, a time series projection would almost certainly give very misleading results. The most feasible alternative method of obtaining net migration figures for 1968 to 1976 is to assume that yearly migration during this period would equal the yearly average of the period 1960-67. This will result in a net figure of 828 engineers migrating into Canada each year during the period 1968 to 1976.

3.4 Reduction Factor

It is not possible to obtain direct data on deaths, retirements and net occupational mobility of engineers. It is possible, however, to construct the theoretical potential stock and to subtract from it the actually observed stock to determine the loss from the profession. This loss or reduction factor can be expressed as a per cent of the theoretical stock and be utilized in order to make appropriate supply adjustments.

The procedure used to compute the reduction factor is as follows:

(1) Add to the total of active engineers in year "t", the Canadian graduates and net immigration from year "t + 1" to obtain the theoretical total for year "t + 1".
(2) Subtract from the theoretical total for time "t + 1", the actual total in time "t + 1".
(3) Express the difference obtained from (2) as a percentage of the theoretical total of time "t + 1" - this is the reduction factor for time "t + 1".

As the actual stock of engineers has been set for the years 1961 through 1966 - it is possible to obtain estimates of the theoretical stock of engineers for these years. The reduction factors for those years are presented in Table 3.8.

TABLE 3.8

Reduction Factor

Year	Reduction Factor
1961-62	.0127
1962-63	.0118
1963-64	.0191
1964-65	.0271
1965-66	.0402

As the reduction factor appears to be growing over time, it was decided to use a time series extrapolation along with the highest historical value observed. The results of the extrapolation for the years 1966-67 to 1975-76 are presented below in Table 3.8(a).

TABLE 3.8 (a)

Reduction Factor

Year	Reduction Factor
1966-67	.0433
1967-68	.0503
1968-69	.0573
1969-70	.0644
1970-71	.0714
1971-72	.0784
1972-73	.0855
1973-74	.0925
1974-75	.0995
1975-76	.1065

Application of the above reduction factors to the projected theoretical totals yields the projected actual totals as presented in Table 3.9.

TABLE 3.9

Projected Actual Stock of Engineers

(Increasing Reduction Factor)

Year	Number of Engineers
1967	56,426
1968	57,158
1969	57,707
1970	58,159
1971	58,181
1972	57,869
1973	57,303
1974	56,575
1975	55,739
1976	54,837

Using the highest historically observed value (.0402) yields the projected actual totals as presented in Table 3.10 below.

TABLE 3.10

Projected Actual Stock of Engineers

(Constant Reduction Factor of .0402)

Year	Number of Engineers
1967	56,609
1968	57,941
1969	59,505
1970	61,389
1971	63,237
1972	65,119
1973	67,101
1974	69,239
1975	71,564
1976	74,096

The different reduction factors because of the compounding feature yield widely differing final stocks.

Except for death and normal age 65 type retirement, the reduction factor is an endogenous variable i.e. its actual value is determined by the state of the labour market. If there is a tight labour market then we are apt to view less engineers retiring at any early age and less engineers switching into other fields of employment. Alternately, with an excess of engineers, more are apt to retire early or to switch to other fields.

Given that total requirements were projected to be 77,954, it is extremely unlikely that the reduction factor will increase through time to a point where the 1976 stock of engineers will be 23,117 short of requirements. With an increasingly tight labour market, it should be expected that the reduction factor will probably not rise above it's historically high value of .0402 which would then yield an excess of requirements of 3,858. If because of a buoyant market, it were to remain at its historically observed value of .0222, the 1976 stock of engineers would be 85,127 which would then mean an excess supply of 7,173 engineers.

CHAPTER 4

IMPLICATIONS OF SUPPLY AND REQUIREMENTS PROJECTIONS

4.1 Supply - Requirements Differential

The total projected requirements for engineers obtained in Chapter 2 was 77,954. Using a reduction factor of .0402, the projected supply of engineers arrived at in Chapter 3 was 74,096. The net market situation projected for engineers is then one of excess demand - 3,858. Given that .0402 is the most likely reduction factor to be observed, we should expect to experience a balanced labour market in engineering as the small gap can probably be closed by utilization of graduates from other disciplines where an excess supply is projected - physics for example.

4.2 Implications of Balance

Although, gross supply is projected to equal gross requirements, there still may be imbalances by degree level and by specialization at any degree level. Studies such as the Ring of Iron carried out by Dr. P. A. Lapp for the Committee of Presidents of Universities of Ontario appears to have great value in identifying and planning for such micro imbalances.

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